

STATE OF CALIFORNIA
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX X

ADVANCED POLLUTION INSTRUMENTATION, INC. (API)
MODEL 400 OZONE ANALYZER

MONITORING AND LABORATORY DIVISION

MARCH 1996

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APPENDIX X

ADVANCED POLLUTION INSTRUMENTATION, INC. (API) MODEL 400 OZONE ANALYZER

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VOLUME II

STANDARD OPERATING PROCEDURES
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APPENDIX X.3

CALIBRATION PROCEDURES
FOR
ADVANCED POLLUTION INSTRUMENTATION, INC. (API)
MODEL 400 OZONE ANALYZER

MONITORING AND LABORATORY DIVISION

MARCH 1996

X.3.0 CALIBRATION PROCEDURES

A Dasibi Model 1003 PC, 1009 CP, or 5009 CP ozone analyzer/calibrator (transfer standard), or equivalent, standardized against a primary standard laboratory ultraviolet photometer is used in calibrations. The response of the analyzer being calibrated is compared to the response of the transfer standard.

X.3.0.1 APPARATUS

1. Dasibi certified ozone analyzer/calibrator.
2. One-quarter inch Teflon tubing for air flow connections.
3. Charcoal zero air scrubber (Gelman Model No. 12011, or equivalent).
4. Calibrated laminar flow device for measuring air flow (Vol-o-flo, or equivalent).
5. Calibration report forms (Figures X.3.0.1, X.3.0.2, and X.3.0.3).
6. Spare scrubber.
7. Simulated cal line if using calibrator for ozone source.

X.3.0.2 OZONE SCRUBBER REPLACEMENT

The policy concerning ozone scrubber replacement is as follows:

1. Replace ozone scrubbers only at the time of calibration, and only after performing an (as-is) calibration. After replacing an ozone scrubber, perform a multipoint calibration.
2. No field scrubber replacement is required for seasonal ozone monitoring. At the end of the ozone season, return the analyzer to the AQM Support Facility for overhaul. The overhaul includes scrubber replacement and a multipoint calibration check.

3. For analyzers operating continuously for a full year, replace the ozone scrubber during the pre-ozone season calibration. Although recommended, it is not necessary to replace the ozone scrubber during the post-ozone season calibration, but continue semi-annual replacements.

X.3.0.3 CALIBRATION AT ALTITUDE

1. Calibrating the API 400 analyzer for altitudes greater than or equal to 1000 feet above mean sea level requires no special adjustments because the analyzer compensates for changes in temperature and pressure. At the time of calibration, verify the operation of the transducers in the analyzer by recording the values of temperature and pressure from the analyzer and from a certified transfer standard for one point.
2. The span setting of the transfer standard is not to be adjusted for altitude. The altitude correction factor is to be applied when calculating the corrected averages of the transfer standard on the Ozone Analyzer Calibration Data Sheet (Figure X.3.0.2); note that transfer standard analyzer models 1008 PC and 5009 CP require no altitude correction if pressure and temperature compensation are turned on, therefore using a factor of 1.000 at all altitudes.

i.e., $\text{Corrected Average (Transfer Standard)} = \text{Average Reading} - \text{Zero Correction} \times \text{True Ozone Correction Factor} \times \text{ACF}$

3. Altitude correction factors are shown on Table X.3.0.1.
4. Calibrate the analyzer as described in Section X.3.0.4.

X.3.0.4 AS-IS CALIBRATION

OTHER THAN ROUTINE CHECKS, ANALYZER REPAIRS OR ADJUSTMENTS SHOULD NOT BE MADE PRIOR TO THE AS-IS CALIBRATION.

NOTE: The ozone scrubber and solenoid valve should not be replaced without first performing an (as-is) calibration.

1. Assemble the equipment as per the diagram shown in Figure X.3.0.4 and allow zero air to flow through the system.
2. While sampling zero air allow both the transfer standard and the analyzer being calibrated to warm-up for at least one hour. The covers of both instruments should be on during the calibration, as the calibration is dependent upon the internal temperature of the analyzer. The transfer standard control frequency readings should be stable, showing no upward or downward trend when the analyzer has reached operating temperature. Some transfer standards are equipped with a positive offset feature; if so set the transfer standard offset dial to zero allowing for the full 50 ppb offset.
3. Record the analyzer identification numbers, analyzer settings and any other pertinent information on the calibration data sheet (Figure X.3.0.2).

NOTE: OBTAIN THE INSTRUMENT INTERNAL SLOPE AND OFFSET FROM THE API FRONT DISPLAY FOLLOWING THESE STEPS:

- a. Press SETUP;
- b. Press MISC;
- c. Press O3;
- d. Press SLOPE;
- e. Press EXIT;
- f. Press OFFSET;
- g. Press EXIT four times to get back to main menu

RECORD THE AS-IS SLOPE AND OFFSET ON THE CALIBRATION DATA SHEET; VERIFY THAT THEY ARE THE SAME AS AT THE END OF THE PREVIOUS CALIBRATION. IF NOT, INVESTIGATE WHEN AND WHY THE ANALYZER WAS RESET BEFORE MAKING ADJUSTMENTS.

4. Adjust the sample air flow rate of the transfer standard to 2.5 SLPM as measured by the calibrated laminar flow device. Measure and record the (as-is) sample air flow rate of the analyzer being calibrated. Connect an 18

inch long Teflon line (1/4" O.D.) to the vent port of the transfer standard and measure the vent flow. The vent flow should be greater than 0.5 LPM.

5. While the analyzer and transfer standard are sampling zero air, record 10 consecutive digital display values in the respective columns labeled "pre-zero" on the calibration data sheet. Calculate the sum and average of the 10 numbers and record the value on the calibration data sheet in the respective blocks. Record the average strip chart (and/or other data acquisition system) reading in the space provided.
6. Set the lamp intensity control (or thumbwheel setting) of the transfer standard to produce an ozone concentration between 50% and 80% of full scale of the analyzer being calibrated as read by the transfer standard.
7. Record ten consecutive digital values in the columns labeled "1st pt" for each analyzer. Calculate the sum and average of the ten numbers and record the value on the calibration data sheet in the appropriate blocks. Record the average strip chart recorder (and/or other data acquisition system device) reading in the appropriate space.
8. Record data for the "2nd Pt", "3rd Pt", and 4th Pt": after adjusting the ozone generator output to approximately 0.40, 0.20, and 0.10 ppm, respectively; calculate and record the sum and average readings. (Use approximately 0.5 ppm and 0.09 ppm as two of the points if also calibrating the output of the station calibrator for daily spans and precision checks).
9. Repeat step 5 and record the value in the volumes marked "post- zero". Average the "pre-zero" and "post-zero" readings and use this value as the zero correction.
10. Calculate corrected averages for the transfer standard analyzer using the formula:

Corrected Average (Transfer Standard) = (Average Reading - Zero Correction) x True Ozone Correction Factor x Altitude Correction Factor (see Table X.3.0.1 for altitude correction factors applicable to Model 1003 PC and 1009 CP; Models 1008 PC and 5009 CP

require no altitude correction if pressure and temperature compensation is turned on, therefore using a factor of 1.000 at all altitudes).

11. Calculate the summation of corrected averages for the transfer standard (S1) by adding the corrected averages for points 1, 2, 3, and 4.
12. Calculate the corrected averages of the analyzer being calibrated using the formula:

$$\text{Corrected Average} = \text{Average Reading} - \text{Zero Correction}$$

NOTE: IF A STRIP CHART RECORDER OR DATA ACQUISITION SYSTEM IS USED FOR PRIMARY DATA RECORDING, THEN THAT DATA SHOULD BE USED IN THE CALCULATIONS INSTEAD OF THE DISPLAY READINGS.

These values, in ppm, should correspond to the analyzer's digital display. If not, check the calibration of the recording device before making adjustments to the analyzer.

13. Calculate the summation of corrected averages for the analyzer being calibrated (S2) by adding the corrected averages for points 1, 2, 3, and 4.
14. Calculate the average percent difference from true ozone:

Percent deviation from true ozone =

$$\frac{S2 - S1}{S1} \times 100$$

15. Using a best fit linear regression, calculate the slope (m) and intercept (b) equation of the calibration line:

Where x = true concentration, in ppm
y = analyzer response, in ppm

16. Calculate the percent change from the previous calibration:

Percent change from the previous calibration =

$$\frac{\text{New Slope} - \text{Old Slope}}{\text{Old Slope}} \times 100$$

17. Record the requested information on the front of the Calibration Report (Figure X.3.0.1).

X.3.0.5 FINAL CALIBRATION

If the percent difference reported in Section X.3.0.4.14 is outside $\pm 5\%$, or if the ozone scrubber is replaced (see Section X.3.0.2), the analyzer must undergo a (final) calibration. Perform the (final) calibration as follows:

1. Challenge the API with zero air until the reading stabilizes (not more than $\pm 2\%$ of range over a 5 minute time period).

NOTE: IF THE ANALYZER FAILS TO STABILIZE ON ZERO AIR AT AN OUTPUT BETWEEN ± 25 PPB, IT WILL BE IMPOSSIBLE TO ENTER ZERO AND IT WILL BE NECESSARY TO REFER TO THE TROUBLESHOOTING SECTION OF THE MANUFACTURER'S MANUAL.

2. ZERO the API by performing the following steps in order:
 - a. Press CALM;
 - b. Key in the calibration password;
 - c. Press ENTER;
 - d. Press ZERO;
 - e. Press ENTER;
 - f. Press EXIT two times.

The API Model 400 is now zeroed, but the blinking cal light and words "HOLD OFF" indicate that data are not being sent out. This status will last approximately 5 minutes.

3. Record 10 display updates on zero air for pre-zero.
4. Challenge the API with a span level of ozone. This level should be between 50% and 80% of full scale. Allow the span level to stabilize for sufficient time to determine that the API reading is within +/- 10% of the true value.

NOTE: IF THE ANALYZER FAILS TO STABILIZE AT A SPAN READING WITHIN +/- 10% OF THE CORRECT SPAN, IT WILL NOT BE POSSIBLE TO SPAN THE INSTRUMENT. CONSULT THE TROUBLESHOOTING SECTION IF THIS HAPPENS.

5. When the span level is stable, SPAN the API by performing the following steps in order:
 - a. Press SETUP;
 - b. Press IZSC;
 - c. Key in the calibration password;
 - d. Press ENTER;
 - e. Press SPAN;
 - f. Enter the ozone concentration in PPB units;
 - g. Press ENTER;
 - h. Press EXIT;
 - i. Press EXIT;
 - j. Press CALM;
 - k. Key in the calibration password;
 - l. Press ENTER;
 - m. Press SPAN;
 - n. Press ENTER;
 - o. Press EXIT. SPAN is now set.
6. Obtain the instrument internal slope and offset from the API front display following these steps:
 - a. Press SETUP;
 - b. Press MISC;
 - c. Press O3;
 - d. Press SLOPE;
 - e. Press EXIT;

- f. Press OFFSET;
 - g. Press EXIT four times.
7. Record the (final) slope and offset on the Calibration Data Sheet (Figure X.3.0.2).
 8. Record on the Calibration Data Sheet 10 display updates at this span level for high point.
 9. Return to Section X.3.0.4 (As-Is Calibration) step 8 to complete the remaining steps of the (final) calibration.

If the analyzer cannot be properly calibrated, refer to the API Instruction Manual for assistance in troubleshooting and repairing the analyzer.

TABLE X.3.0.1

Span Correction Factor for Transfer Standard

ELEVATION (Feet above sea level)	ALTITUDE CORRECTION FACTOR (ACF)
0	1.000
500	1.000
1000	1.037
1500	1.056
2000	1.075
2500	1.095
3000	1.116
3500	1.136
4000	1.158
4500	1.179
5000	1.202
5500	1.225
6000	1.248
6500	1.272
7000	1.296
7500	1.321
8000	1.347
8500	1.372
9000	1.399
9500	1.426
10000	1.454

CALIFORNIA AIR RESOURCES BOARD
API MODEL 400 OZONE ANALYZER
CALIBRATION REPORT

TO: LARRY MOLEK, MANAGER
AIR QUALITY MONITORING, NORTH

LOG NUMBER
CALIBRATION DATE:

FROM: BOB EVANOSKY
INSTRUMENT TECH III

IDENTIFICATION

Instrument	API	Site Name
Model Number	400	Site Number
Property Number		Site
Serial Number		Location
Previous Calibration Log Number		Instrument Property of
Elevation		Barometric Pressure " Hg

CALIBRATION STANDARDS

Standard	I.D. Number	Certification Date	Certified Value Or Factor
Dasibi 1003 PC			

CALIBRATION RESULTS

Component	OZONE		
Instrument Range, ppm	0 - 1		
Initial Instrument Slope			
Initial Instrument Offset			
Air Flow Rate, SCCM			
Air Flow Indication			
Best Fit Linear Regression Slope			
(x = True; Y = Intercept			
"As Is" Deviation from True	%		
"Final" Deviation from True	%		
Change from Previous Calibration, % (date	%		
Final Instrument Slope			
Final Instrument Offset			

COMMENTS:

Calibrated By BOB EVANOSKY

Checked By _____

Figure X.3.0.1
Calibration Report

CALIFORNIA AIR RESOURCES BOARD
OZONE ANALYZER CALIBRATION DATA SHEET
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Site Name: _____ Calibration: As Is ☐ Final ☐

Site Number: _____ Date: _____

Log Number: _____

Sum of Corrected Averages (Transfer Standard), S_1 = _____ (ppm)

Sum of Corrected Averages (Analyzer Data Acquisition System, DAS):
 S_2 = _____ (ppm)

Percent Deviation from True = $\frac{S_2 - S_1}{S_1} \times 100\% =$ _____ %

Linear Regression:

Analyzer Response (DAS), ppm = $\left(\frac{\text{Slope}}{\text{Slope}} \right) \times \text{True O}_3 \text{ Conc.} + \left(\frac{\text{Intercept}}{\text{Intercept}} \right) \text{ ppm}$

As Is Change From Previous Calibration Dated _____:

$\left(\frac{\text{As Is Slope} - \text{Old Slope}}{\text{Old Slope}} \right) \times 100\% = \left(\frac{\text{Slope} - \text{Old Slope}}{\text{Old Slope}} \right) \times 100\% =$ _____ %

Comments: _____

Calibrated by _____ Checked by _____

ADD-23 (1/84)

Figure X.3.0.2
Ozone Analyzer Calibration Datasheet (cont'd)

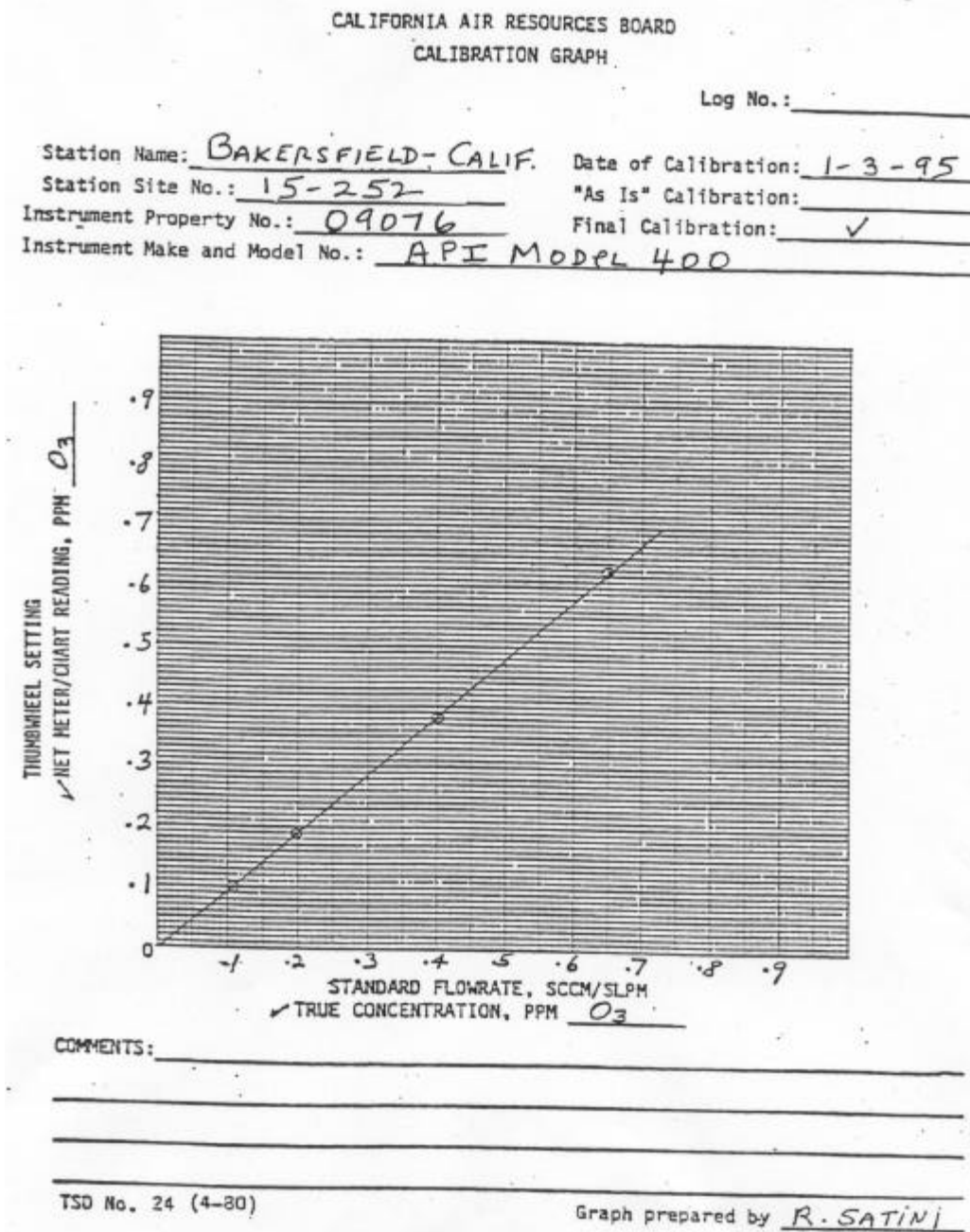


Figure X.3.0.3
Calibration Graph

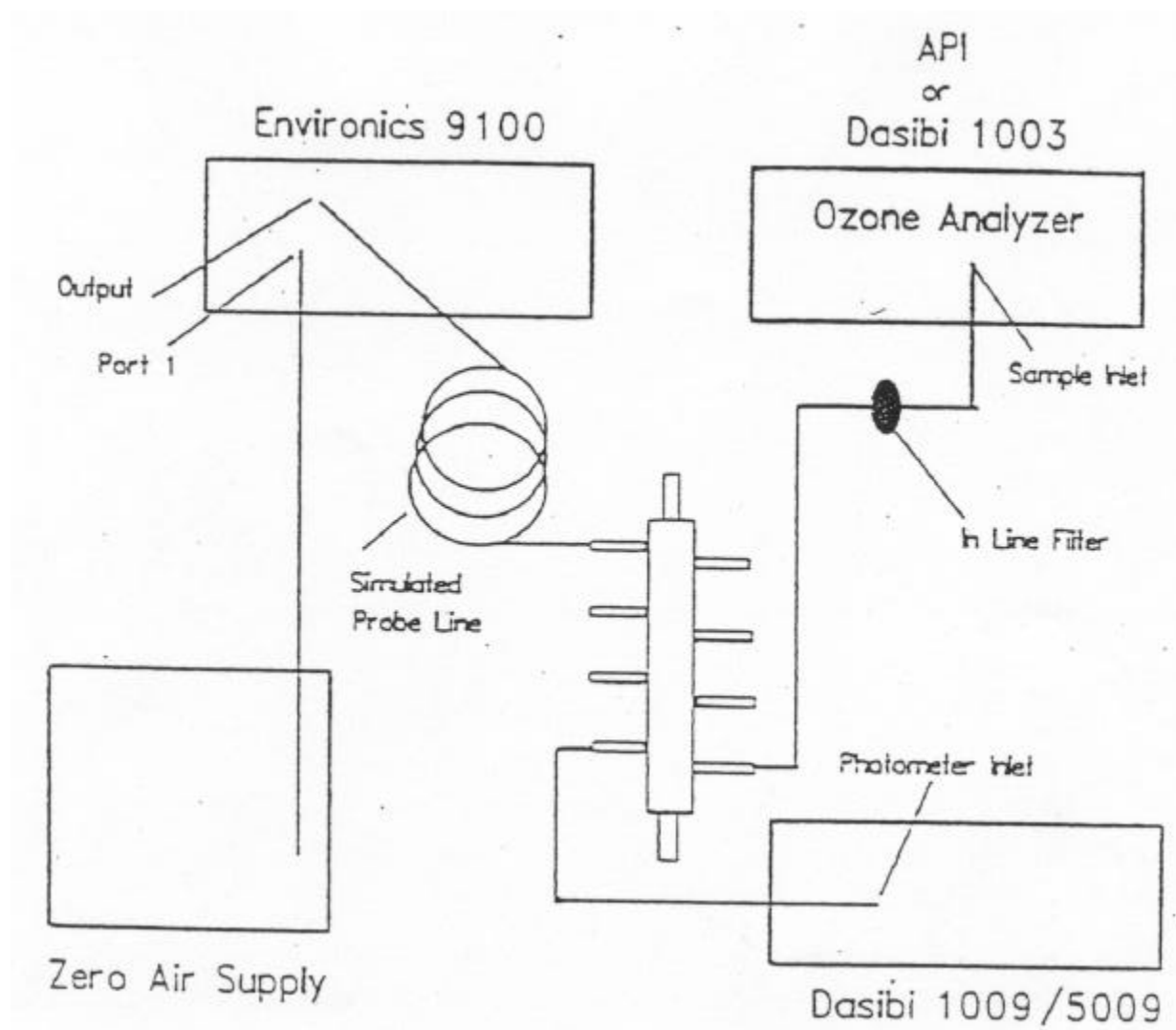


Figure X.3.0.4
Calibration Diagram